Pycnoclavella (Tunicata: Ascidiacea) species from the West Indian Ocean

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Three new *Pycnoclavella* species, recorded from a number of locations in Algoa and Plettenberg bays, suggest an unusual diversity for this genus in South African waters and indicate the extent to which the fauna of this part of the world is incompletely explored and documented. One of the species, with sandy thread-like zooids forming loose aggregates, is in the *stanleyi* species-group; another has zooids partially embedded in solid test as do other species of the *aurilucens* group to which it belongs; and a third species is in the *detorta* group with the thoraces of its separated zooids turned at right angles to the longitudinal axis of the zooids and larvae that closely resemble those of *Euclavella* Kott, 1990. In the latter species the pharyngeal wall is reduced to a scaffolding of longitudinal and transverse branchial sinuses framing large perforations similar to those that in many abyssal species replace the small stigmata of most shallow water taxa of the Ascidiacea. The environmental pressures selecting for this remarkable adaptation are not known. A key to *Pycnoclavella* spp. recorded from the western Indian Ocean is included.

Key words: pharyngeal wall, otolith, ocellus, larvae, inverted tubular adhesive organs.

INTRODUCTION

The tunicates of the West Indian Ocean off South Africa have been reported on by Hartmeyer (1905, 1911, 1912, 1913), Michaelsen (1918–1920, 1921, 1934), Millar (1955, 1956, 1960, 1962, 1964, 1988), Monniot (1997a,b, 2002), Monniot & Monniot (1976, 1999), Monniot *et al.* (2001), Sluiter (1898) and Vasseur (1967, 1969, 1970). These reports have established that the Class Ascidiacea is well represented in these waters by a rich and diverse fauna. Nevertheless, species of *Pycnoclavella* have been reported only once (Monniot 1997a). The present records represent such prolific populations of the three newly described species that it is unlikely that they are other than common components of the fauna. Apparently, previous sampling has been far from comprehensive and it is probable that much remains to be learnt of this fauna. Sampling of ascidian populations by scuba diving in locations previously inaccessible and unexplored may be, to some extent at least, the explanation for the recent increase in the number of known species of these sessile organisms in this and many other parts of the world.

The family Pycnoclavellidae Kott, 1990, is distinguished from Clavelinidae by its small zooids; a replicative process involving horizontal division across the abdomen (demonstrated by Trason 1963) rather than the generation of buds in the terminal ampullae of the vascular stolon (as in Clavelinidae); smaller gonads and a limited number of embryos produced by each zooid; unique larval tubular adhesive organs; and a reduced otolith which often is lost altogether (see also Kott 2003). Although Kott (1990, 2003) regarded fertilization at the base of the oviduct as a further characteristic of Pycnoclavellidae, embryos at all stages are found being incubated in the terminal atrial cavity of the new species, *P. narcissus* n.sp., and other species in the *detorta* group (to which *P narcissus* belongs). It appears that this species-group is exceptional in that fertilization is at the top rather than at the base of the oviduct. Also, specimens of *Pycnoclavella* occasionally have been erroneously assigned to the genus *Archidistoma,* a genus of the Polycitoridae (see Kott 2003).

Pycnoclavella spp. already known from this region are *P. diminuta* (Kott, 1957), *P. dublum* (Monniot, 1997a) (>*P. dubium*: Kott 2003 *sic*) and *P. auracea* (Monniot, 1997a) from Mozambique. These, together with the three species described below are set out in the following key. The species-groups indicated are in Kott (1990)

Key to species of *Pycnoclavella* reported from the West Indian Ocean

1. Sand never in test; atrial aperture terminal; embryos fertilized at top of oviduct ..... (*detorta* group) — 2

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— Sand usually in test; branchial aperture terminal; embryos fertilized at base of oviduct 3
2. Stigmata present in branchial sac . . . . . *P. auracea* (Monniot, 1997)
— Stigmata not present in branchial sac . . . . . *P. narcissus* n. sp.
3. Abdomina embedded in basal test . . . . . (*aurilucens* group) — *P. inflorescens* n.sp.
— Abdomina not embedded in basal test . . . . . (*stanleyi* group) — 4
4. Stigmata 40 or more per row 5
— Stigmata not more than 20 per row . . . . . *P. filamentosa* n.sp.
5. Stigmata 40–60 per row . . . . . *P. diminuta* (Kott, 1957)
— Stigmata about 100 per row . . . . . *P. dublum* (Monniot, 1997)

The present collection, from scuba diving in Algoa Bay and Plettenberg Bay, was made by Shirley Parker-Nance from the University of Port Elizabeth. Accession numbers for specimens lodged in the South African Museum are indicated by the prefix SAM.

TAXONOMY

***Pycnoclavella filamentosa* n.sp.**, Fig. 1A,B

Material examined

Type material. Holotype: SAM 25828, Algoa Bay (reef Bell Buoy 33°58.98′S, 25°41.80′E 20 m, coll. Shirley Parker-Nance 17.3.02,). Paratype: SAM 25830, Plettenberg Bay (reef Groot Bank 34°00.46′S, 23°29.79′E 16 m, coll. Shirley Parker-Nance 22.3.02).

Collector's notes. Colonies are large, fluffy, hemispherical heads with white or orange thoraces of the zooids standing free above the sandy surface of the colony. Individual zooids are encased in sand, forming narrow sandy pillars adhering to one another to form the hemi-spherical head. Colonies break apart easily. Some colonies have both orange and white zooids.

Description

Colonies are sandy aggregations of long, thread-like zooids lying parallel to one another and loosely stuck together by adjacent zooids sticking to the same sand grains. Clumps of zooids up to 10 cm high and 1–2 cm in diameter are grouped together to form masses up to 30 cm in maximum extent, their thoraces projecting separately from the sandy coating at the base of colonies. Although basal stolons connecting the zooids were not observed, it is possible that they are too delicate to survive abrasion by the sand attached around the extremely thin and delicate test surrounding the lower half of the zooids. In life the free thorax is white or orange. In preservative there are traces of brown pigment in the body wall of the thread-like zooids.

The small, thread-like zooids have especially small thoraces with delicate transparent test. The smooth-rimmed apertures are close together on short stumpy siphons at the anterior end of the zooid. A ring of branchial tentacles is at the base of the branchial siphon and a short band of unperforated pharyngeal wall is behind it. Three rows of stigmata have 10–15 stigmata per row, but brown-yellow cells in the haemocoel as well as the contraction of thoracic muscles obscure the pharynx and the number of stigmata could not be counted accurately. The anterior and the posterior rows of stigmata extend, respectively, anteriorly and posteriorly along each side of the mid-dorsal line dorsal to extensive unperforated areas at each end of the branchial sac. Parallel bands of longitudinal muscles extend the length of the thorax and continue in finer but more numerous bands along each side of the abdomen.

The greater part of the length of these zooids is occupied by the long oesophageal neck. The more or less quadrate stomach is at the posterior end of the gut loop, with a long duodenal area between the stomach and the oval posterior stomach in the pole of the loop. About 6–8 pyriform testis follicles are in a clump in the posterior end of the gut loop.

Remarks

The zooids and colonies are characteristic of the *stanleyi* group of species (see Kott 1990), all with small, narrow zooids and atrial and branchial apertures close together at the anterior end, lacking common test (the zooids being separate and only connected by basal stolons), testes follicles reduced in number and fertilization at the base of the oviduct. *Pycnoclavella elongata* Kott, 1990, is the only species distinguished by its more numerous rows of stigmata, while the others, including the present species have only three rows. The species is distinguished from others in the *stanleyi* species-group by its large zooids (to 10 cm long), related species (*P. stanleyi* Berrill and Abbott, 1949, and *P. tabella* Kott, 1990) having zooids to only 5 cm. *Pycnoclavella tabella* appears to resemble the

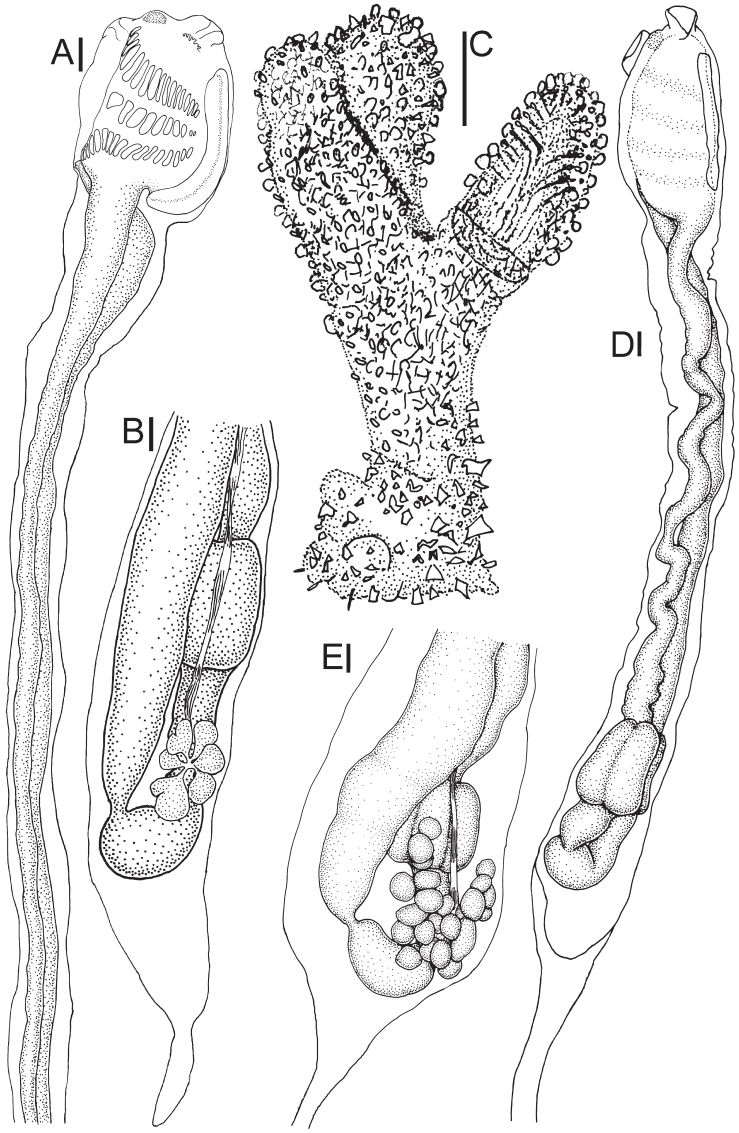

Fig. 1. *Pycnoclavella filamentosa* (SAM 255828): **A**, right side of thorax and oesophageal neck; **B**, left side of posterior end of gut loop. *Pycnoclavella inflorescens*: **C**, colony with portion of one lobe cut away to show position of the zooids(SAM 25624); zooid (SAM 25627); **D**, right side of whole zooid; **E**, left side of distal part of gut loop showing gonads dorsal to the loop. Scale bars: A, B, D, E = 0.1 mm; C = 1.0 cm.

present species most closely, having relatively few stigmata per row but, in addition to its smaller zooids, it is distinguished by its brown spherical cells in the test that do not occur in the present species, and by its bi-lobed testis (compared with the relatively numerous testis follicles of the present species). The larvae of the present species are not known and at present cannot be compared with the large larvae of other species in the group which all have only two adhesive organs.

***Pycnoclavella inflorescens* n.sp.**, Fig. 1C–E

Material examined

Type material. Holotype: SAM25827, Plettenberg Bay (reef Groot Bank 34°00.46′S, 23°29.79′E 15–17m, coll. Shirley Parker-Nance 22.3.02). Paratype: SAM25824, Algoa Bay (reef White Sands 33°59.988′S, 25°42.505′E 15 m, coll. Shirley Parker-Nance 20.3.02).

Additional material. SAM25825, Algoa Bay (reef

White Sands 34°00.37′S, 25°43.17′E 21 m, coll. Shirley Parker-Nance 14.3.02); SAM25826, Algoa Bay (reef Riy Banks; 33°59.173′S, 25°51.798′E 30 m, coll. Shirley Parker-Nance 15.3.02); ? SAM25829, Algoa Bay (reef Roman Rock-Table Top 33°58.901′S, 025°41.494′E 10 m, coll. S. Parker-Nance 14.3.02).

Collectors notes. Short, irregular, fluffy digits or finger-like lobes branching from a common base. Colonies have sand and shell fragments in the test, especially in the outer layer. The orange or white thorax of the zooid is free from the sandy test and gives the colony the orange or white colour *in situ.*

Description

Colonies are upright, conical to cylindrical masses to 7 cm high overall, often with one or two conical side branches, or with the upper surface divided in two or three terminal lobes. Thoraces project separately from the solid sand-embedded layer of test around the even, outer surface of the colony. Sand is sparse in the centre of the colonies, where the vascular stolons of the zooids can be seen projecting toward the base of the colony. In life, the thoraces are translucent, white or yellow.

Zooids are robust, but obscured by contraction and by the brown-yellow cells in the haemocoele in the available colonies. Longitudinal bands of muscles are on the thorax and extend as fine bands along each side of the abdomen. There appear to be four or five rows of stigmata but these could not be counted accurately. The quadrate stomach is in the posterior end of the gut loop. The testis follicles in a large clump of 10–12 (or more) pyriform follicles are against the dorsal side of the posterior end of the gut loop.

Remarks

The colonies resemble those of the *aurilucens* group (see Kott 1990) in which the zooids are partially embedded in central common test. *Pycnoclavella minuta* Millar, 1953, a member of this species-group, is reported from the tropical Atlantic coast of Africa. It also has small, partially embedded zooids with four rows of stigmata but differs from the present species in having part of the abdomen as well as the thorax independent of the basal common test. *Pycnoclavella aurilucens* Garstang, 1891 (from the English Channel), lacks sand in the test and has seven rows of stigmata; and *P. arenosa* Kott, 1972 (from South Australia), has very similar colonies, with sand around the outer layer of test and absent from the central core and small thoraces projecting from the surface. The latter species resembles the present one most closely. However, the South Australian species has six rows of stigmata rather than four or five. Larvae, that may help to distinguish the present species from others, are not yet known.

The specimen questionably assigned to this species (SAM 25829) forms firm cushions 10–20 cm diameter and orange in life (collector's notes). Sand is embedded throughout and the colony lacks the almost sand-free central core of test of *P. inflorescens.* The test readily disintegrates. Nevertheless, abdomina are embedded and the delicate thoraces project free from the surface as in the present species; and, although the zooids are small, contracted and their structure is obscured by the brown yellow pigment cells in the haemocoel, four or five rows of stigmata were detected, comprising a further similarity to the present species.

Pycnoclavella narcissus **n.sp.**, Fig. 2A–F

Material examined

Type material. Holotype: SAM25818, Algoa Bay (reef White Sands 33°59.919S, 25°42.504E 15 m, coll. S. Parker-Nance 21.3.02). Paratype: SAM25819, Algoa Bay (reef White Sands 33°59.988S, 25° 42.505E 15 m, coll. S. Parker-Nance 21.3.02).

Additional material. SAM 25820, Algoa Bay (Roman Rock 33°58.901S, 25°41.494E 10 m, coll. S. Parker-Nance 14.3.02); SAM25821, SAM25822, Algoa Bay (reef Riy Banks 33°59.173S, 25°51.798E 32 m, coll. S. Parker-Nance 15.3.02); SAM 25823, Algoa Bay (reef White Sands 33°59.988S, 25°42.505E 15 m, coll. S. Parker-Nance 20.3.02).

Collectors notes. Commonly known as choir boys, colonies form patches 5–10 cm long, 2–3 cm wide and about 3–4 cm high. They are found on most of the reefs in Algoa Bay, and are commonly found attached to the edge of a fan-shaped orange sponge. In life colonies are dark and light yellow, light blue (electric blue) as well as a light blue-green colour.

Description

Colonies are flattened, upright masses (5–10 cm long and 2–3 cm wide) of long (3–4 cm), straight, vertical, cylindrical stalks arising from a basal mass of test (about 1 cm thick), which is closely attached to the edge of a red-orange fan sponge from which it is removed only with the greatest difficulty. The vertical stalks subdivide into terminal branches (about 1 cm long), each with an expanded terminal

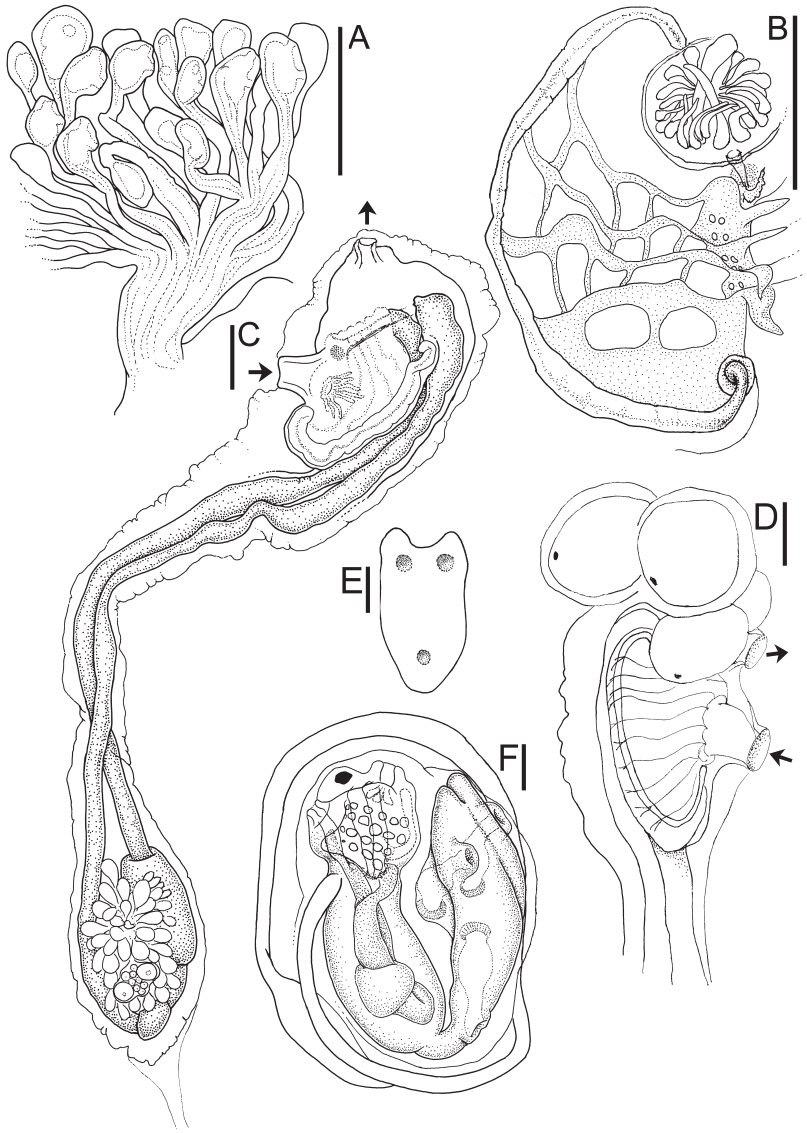

Fig. 2. *Pycnoclavella narcissus* (SAM 25818). **A**, colony; **B**, right side of branchial sac showing branchial tentacles, dorsal languets, endostyle and oesophageal opening; **C**, whole zooid showing thorax turned at right angles to the longitudinal axis; **D**, thorax showing embryos in the brood pouch; **E**, front view of larval trunk showing opening of the adhesive organs (diagrammatic); **F**, right side of larva. Scale bars: A = 1.0 cm; B, C, D = 1.0 mm; E = 0.2 mm; F = 0.1 mm.

head containing the thorax and a narrow stalk containing the upper part of the oesophageal neck of a single zooid. The vertical common stalks each contain 4–6 long parallel abdomina. The posterior ends of the abdomina and the posterior abdominal vascular stolons extend into the solid basal test. In life the colour of the stalks and thoraces is either orange (SAM 25820), light yellow (SAM 25818, SAM 25819, SAM 25823), electric blue (SAM 25821), or light green-blue (SAM 25822). In preservative the test is whitish and translucent. The thoracic test is delicate and flaccid, but the test of the stalk, the common stalks and the base is firm and tough.

Thoraces are turned through 90 degrees on the top of the stalk with both smooth-rimmed apertures on one side of the head, the atrial aperture near the top with the opening directed upwards and the branchial aperture lower down near the top of the

stalk with its opening directed toward the base of the colony. The result of this rotation of the thorax is that the long endostyle extends around it – on the top of the stalk and up along the side of the thorax opposite the apertures. The oesophagus extends down the side of the zooid outside the distal two-thirds of the endostyle and the rectum and gonoducts, outside the oesophagus, also extend along the ventral side of the thorax to the corner of the atrial cavity at the top of the ventral side of thorax. Up to six embryos at different stages of development are incubated in the atrial cavity across the terminal end of the zooid. Both branchial and atrial siphons are short and surrounded by circular muscles. About 15 longitudinal muscles radiate from around the base of the siphons to the endostyle where they break up into short branches. A connection between the thoracic muscles and the fine bands along each side of the abdomen has not been observed. Two close circles of about 24 robust, curved, branchial tentacles are around the base of the branchial siphon, the larger tentacles in the outer circle. The mid-dorsal and the mid-ventral tentacle in the outer circle are both especially long and robust. Ventrally, the outer circle of tentacles is close to the prepharyngeal groove, the prepharyngeal region being very narrow and the anterior end of the endostyle sometimes appears to be beneath the prepharyngeal groove and the base of the tentacles. The dorsal tubercle is a simple pit-like opening behind the branchial tentacles. A mid-dorsal tongue-like papillum projects from the pharyngeal wall behind the prepharyngeal ring where there is a broad area of unperforated pharynx. The perforations in the pharyngeal wall are in four rows, separated from one another and from the anterior unperforated part of the pharynx by a conspicuous transverse sinus, each with a pointed and sometimes lobed triangular, transversely oriented languet in the mid-dorsal line. The pharyngeal perforations are long, wide openings, six in each of the first two rows, five in the third row and only two in the last row. They are separated by narrow strips of pharyngeal wall and are difficult to count in the contracted specimens owing to the fragility of the pharyngeal wall. Occasionally, two pairs of circular perforations were detected in the interspace between the transverse sinuses in the strip of unperforated pharyngeal wall along each side of the mid-dorsal line. A long band of unperforated pharyngeal wall is also at the posterior end of the thorax. The distal end of the endostyle makes a conspicuous curve into the oesophageal opening. This may have resulted from the bending of the thorax at the top of the stalk.

The long neck containing oesophagus and rectum occupies most of the straight, upright stalk of the zooid, and the more or less rectangular stomach is toward the posterior end. A long, slightly curved posterior stomach is behind the stomach in the descending limb of the gut loop, and the ascending limb of the gut loop is entirely occupied by the rectum. A cluster of 20–30 pyriform testis follicles is at the posterior end of the abdomen in the gut loop and a large sac-like ovary with eggs of varying sizes is in the centre surrounded by testis follicles.

Larvae are large, the trunk to 2 mm long and with a broad, flat tail wound almost one-and-a-half times around it. The larval thorax has four rows of conspicuously circular apertures, six in the first two rows, five in the third and two in the last row as in the adult thorax. An ocellus is present but no otolith. The anterior end of the trunk is a broad, slightly flattened frontal plate with a median notch at the top. The plate contains three tri-radially arranged, rather thick, cylindrical, tubular adhesive organs, one opening in the middle of the lower part of the frontal plate and the other two, respectively, in the right and left horns of the plate (separated by the median notch). The openings to the surface are relatively large, more or less sessile, circular openings to cylindrical tubes that converge toward one another and then expand into oval bulbous chambers slightly constricted off from the spherical terminal ampullae lined with columnar cells close to one another in the centre of the plate.

Remarks

This species, with the stomach and gonads at the posterior end of a long abdomen, relatively short thorax and smooth-rimmed apertures are characteristic of the genus *Pycnoclavella.* The thorax, rotated through 90 or more degrees, is like others in the *detorta* group (see Kott 1990), which contains the tropical Indo-West Pacific *P. detorta* (Sluiter, 1904), the South Australian temperate *P. aurantia* Kott, 1990, *P. kottae* (Millar, 1960) known only from Three Kings I at the northern tip of New Zealand, and *P. auracea* (Monniot, 1997a) from Mozambique. The *detorta* group also difffers from most other species in the family Pycnoclavellidae by the lack of sand on the stalk or basal test, the unusually stiff and rigid stalk and fertilization in the brood pouch at the top of the zooids rather than at the posterior

end of the abdomen.

Although a small otolith is present in a few species of this genus (*P. aurilucens* Garstang, 1891, *P. stanleyi* Berrill & Abbott, 1949, and *P. minuta* Millar, 1953), most other species in the genus, like the present one, have a larval ocellus but no otolith. Only the larvae of *P. aurantia* and *P. kottae* are not known. Although Monniot (1997a) did not mention the absence of the otolith in *P. auracea,* he did not show one in his figure (Monniot 1997a: fig. 3E) and very likely it does not occur.

Further, the adhesive apparatus in the larva figured by Monniot is difficult to interpret, and it is probable that inverted tubular adhesive organs were overlooked in the larva, which otherwise resembles the larva of the present species.

Although the present species sometimes is reported to be blue, most colonies are reported to be the same orange/yellow colour as *P. aurantia, P. auracea* and *P. kottae* (newly recorded photographed colonies from Three Kings I, New Zealand: Malcolm Francis, pers.comm.). Some blue colour is also seen in the zooids of *P. detorta* (see Kott 1990: pl. 51) but the characteristic orange/yellow pigment (found in other species of the genus) predominates in the stalk and in the large dorsal and ventral blood sinuses.

Thus, despite its general similarity to other *Pycnoclavella,* especially those in the *detorta* group, the present species is distinguished by the absence of the usual small cilia-lined stigmata in the branchial sac. It is not known how this species maintains the usual feeding current without the cilia that usually drive it. Possibly the pharynx and the apertures of these stalked zooids are so orientated to use prevailing external currents to maintain adequate feeding currents through the pharynx.

The thick adhesive organs, each with a spherical terminal ampulla, closely resemble those of *Euclavella claviformis* (Herdman, 1899), a monotypic genus also thought to be in the Pycnoclavellidae (see Kott 1990)

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